Technical Notes

UTILCELL
CELULAS DE CARGA - LOAD CELLS
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MECHANICAL CONNECTIONS IN TANKS

The intention of this technical note is to help on the identification of some common critical points in the interaction of the tank / hopper / silo / reactor with external mechanical connecting elements, from a weighing point of view, such as:

- Inlet and outlet product pipes
- The security features against horizontal, vertical and non-rotating movements
- Bending effects of beams and legs

As well as provide examples of generic solutions to these problems. We know are not the only existent, nor are they to be optimal, however they may serve as guidance for your best solution in each case.

The first target to consider when performing an external mechanical connection in a weighing system is to allow a free vertical movement in the weighing area, without any tension or friction.

For our convenience, we use the word “tank” as a generic of tank/silo/hopper/reactor, etcetera (Any vessel where we introduce product).

Inlet and outlet product pipes

For weighing well, a tank must be free of any tension produced by the inlet and outlet product pipes. When the load is applied, the tank and the structures have a small movement of a few millimeters, probably undetectable at first sight, but it must move free to this natural movement.

When making a connection we must identify the "critical" points of the installation. The concept to consider is that we must leave enough clearance in the connecting hose, so that, the relative motion between the hose and the tank does not affect our measurement.

Sources of bending/deformation:

- Bending/deformation of the load cells
- Bending/deformation of the tank
- Bending/deformation of the legs or structures supporting the tank
- Bending/deformation of ground
- Movements caused by tubes themselves (due to the own tube by uploading material and/or thermal expansion due to the anchoring structures of the tubes, etc.)

Recommended solutions:

1. Choose an **adecuated diameter tube** to our caudal and also as much flexible as possible.
2. **Maximize the L distance**, between the tank and the fixing structure.The greater the distance the lower resistance caused by pipe movement/flexion, to minimize the tension generated when the tank is full and get a Δh (Increment in height) as shown in Fig. 1-b.

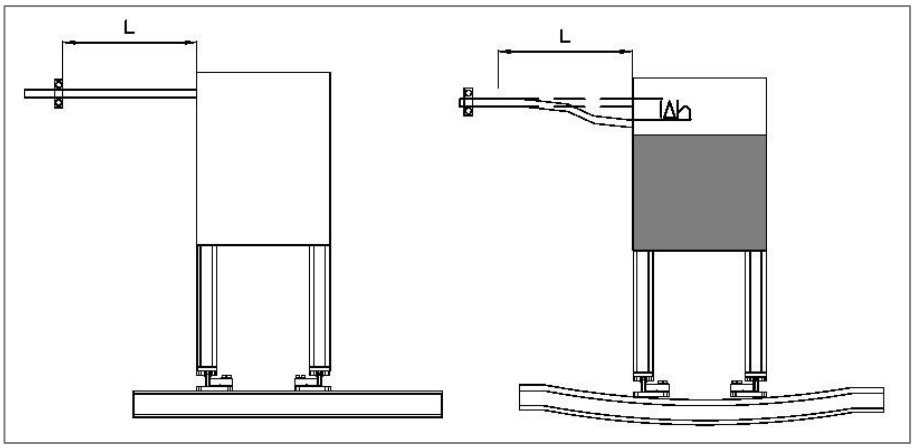


Fig. 1-a: Empty tank Fig. 1-b: Full tank

3. Insert a flexible hose to minimize the opposition to the movement Fig. 2-b (A).

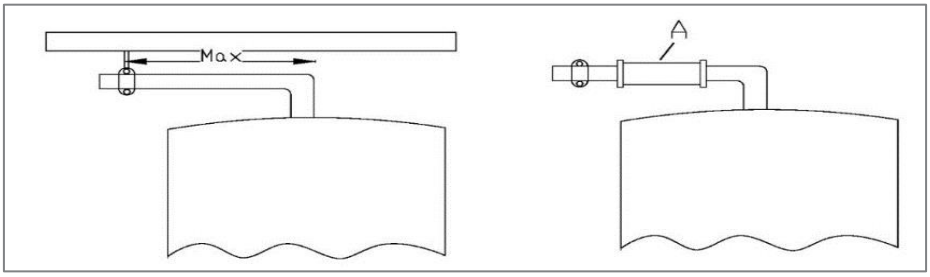
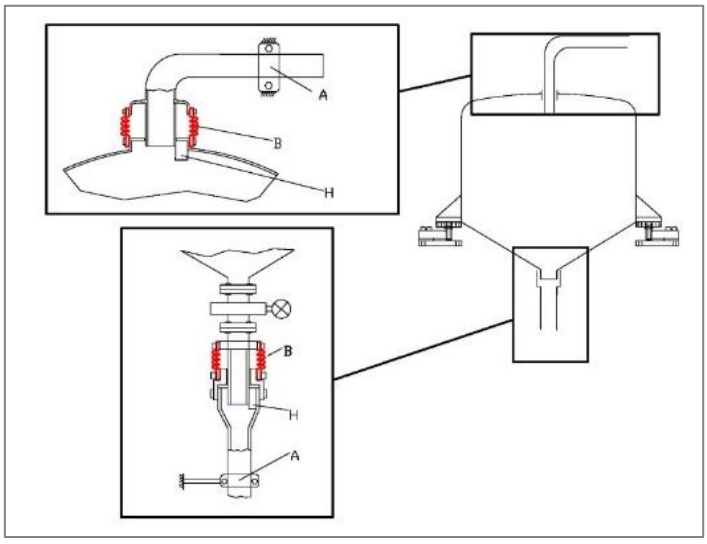


Fig. 2-a: Maximize the Distance Fig. 2-b: Flexible Hose

4. **Flexible joints** on the connections in inlet and outlet vertical product Fig.3-a.



A- Mounting bracket

B- Flexible connection hose

H- Gap between tank and pipe input / output

Fig. 3-a: Inlet and outlet connections

Anchor systems for lift-off prevention

To assure the stability of a tank, you can add as many clamping elements as deemed necessary to protect against strong winds, against impacts, earthquakes or non-centered loads. These calculations must be done before installation by the responsible structural engineer of the installation and usually depends on the location, surroundings and the own dimensions and structure of the tank, as well as, the level of security you want to guarantee.

In addition to safety, from the weighing point of view, a good anchoring system design is very important to get an accurate weighing system, because they must allow a certain freedom of movement to the tank.

Fig. 4-a shows examples of vertical anchors or lift-off prevention systems, using restraint rods to limit tank's movement but allowing some freedom for the proper weighing. Rods must be left with a clearance (A) to permit a minimum vertical or horizontal movement depending on the case, but not greater than 2mm. We must also consider making a drill with a significant larger diameter than the lift –off prevention bar (approx. +20%) for letting a gap D, to avoid frictions and mechanical constrains and having a good weighing system.

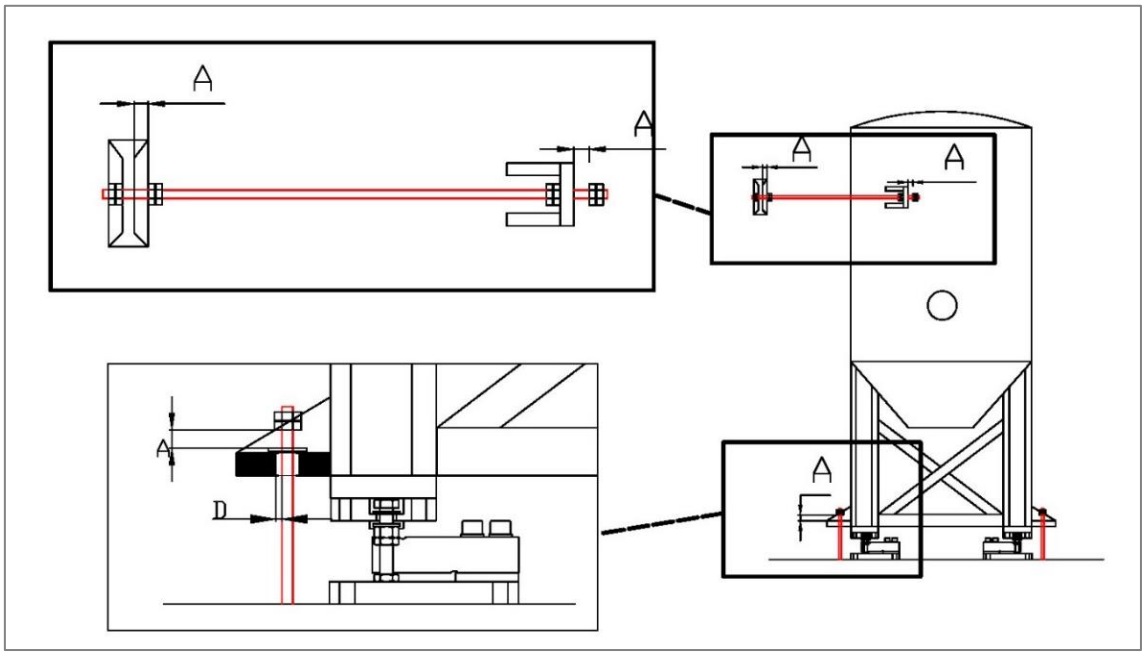


Fig. 4-a: Vertical and horizontal anchor system

A- Maximum recommended clearance of 2mm

D- Clearance needed for a good weight, usually +20% of the drill diameter

Anchor systems for horizontal fixing and non-rotation

To limit horizontal tank's movement, due to lateral winds and due to engine torques/agitators, you can secure it with additional horizontal fasteners.

The solution proposed is using horizontal rods to limit the tank's movement, but at the same time, they have to allow a certain freedom of movement to the tank. So that the tank can perform its function of weighing accurately without excessive constraint. In the same way that the vertical restraint, the rods should be strong enough to support a possible horizontal movement of the tank and must be calculated by a qualified structural engineer.

As we can see on Fig. 4-b, a system against non-rotating and horizontal movements can be solved by supports radially placed to the tank, 3 supports at 120° or 4 supports at 90°.

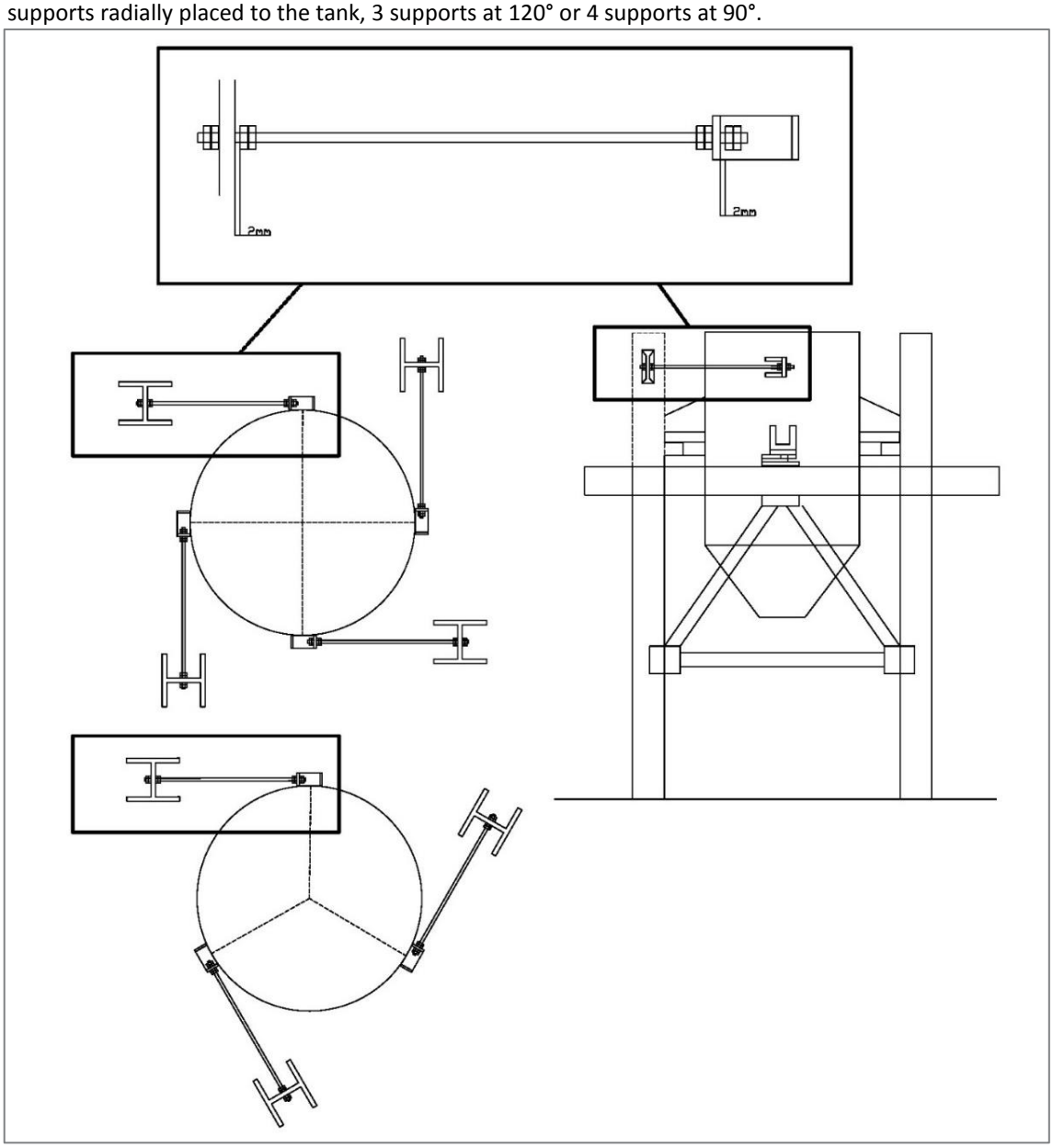


Fig. 4-b: Non-rotating anchor system for 3 or 4 supports

Security system for suspended tanks

Weighing tank in suspension can be solved by using tension load cells (type S) interspersed with the suspended tank rods to the upper structure. In this case is vital to place an additional safety rods to assure tank's fastening in case of load cells will broke and to avoid tank's fall down producing any damage.

These rods must be strong enough to withstand the fall of the tank in any condition, including initial impact at full load. This calculation must be done before installation by a qualified structural engineer responsible of the installation.

Fig. 5-a shows an example of how to install additional check rods. The tank will always be supported by the rods that load cells has. The additional security check rods must has an approximate clearance A of 2mm.

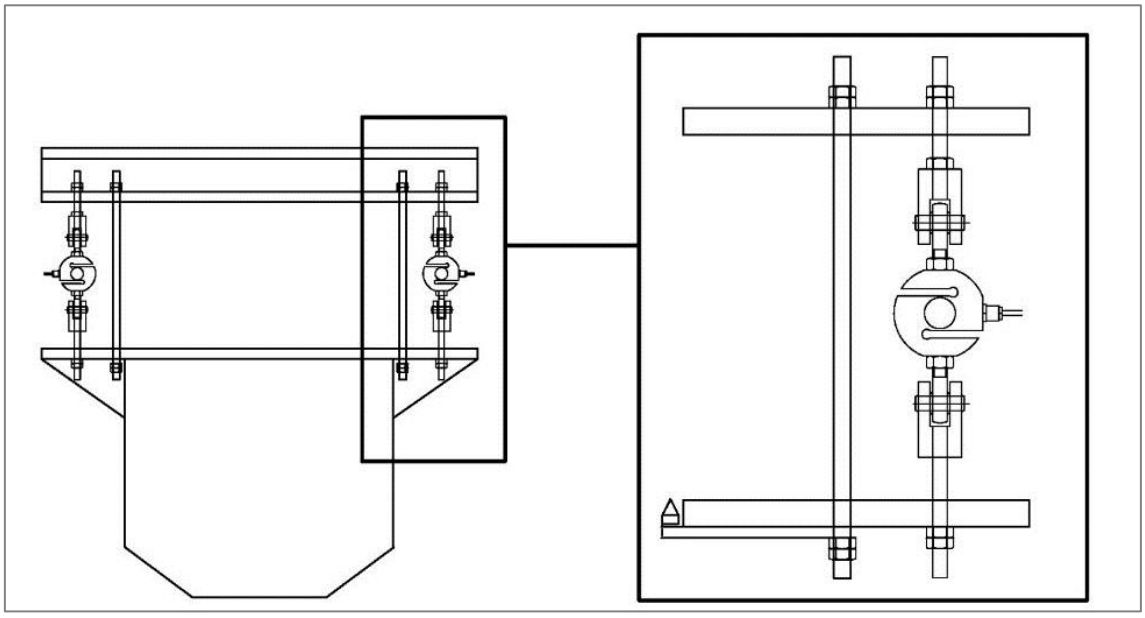


Fig. 6-a: Security System for a suspended tank

A- Max. recommended clearance of 2mm.

Reinforcements in supporting structures

When introducing weighing systems in tanks, we has to reinforce some critical parts to avoid deformations that can prejudice the weight and the installation.

A) Reinforcement against deflection of support beams

Sometimes load cells are installed on horizontal beams that are not firm enough and tend to flexion, producing weighing errors. To solve the problem we can perform reinforcement anchors bellow the anchor points of the cells as shown on Fig 6-b.

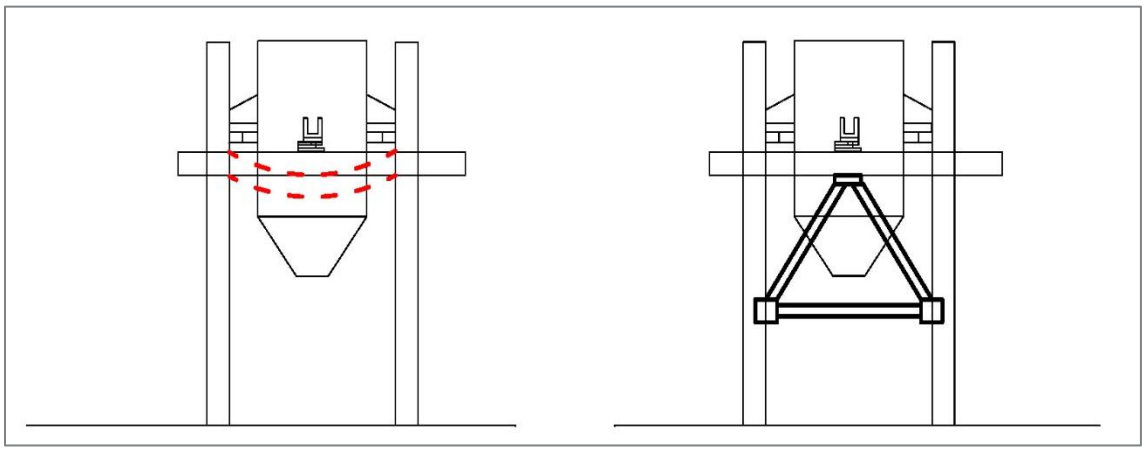


Fig. 7-a: Tank on beam without reinforcement

Fig. 6-b: Tank on beam with reinforcement

B) Reinforcement of tank legs.

When load cells are inserted under the silo legs, the effect of the load can cause that legs tend to open or move horizontally. We must take in mind that many tanks are designed to be anchored directly to the ground. Introducing the load cells can lose the fixed union and the legs can move. That movement can cause errors on the measure, introducing lateral forces, as well as, can prejudice the security of the system.

To fix the leg movement we can reinforce them by the introduction of a frame between the legs and by the use of restraint rods as shown on Fig. 7-b.

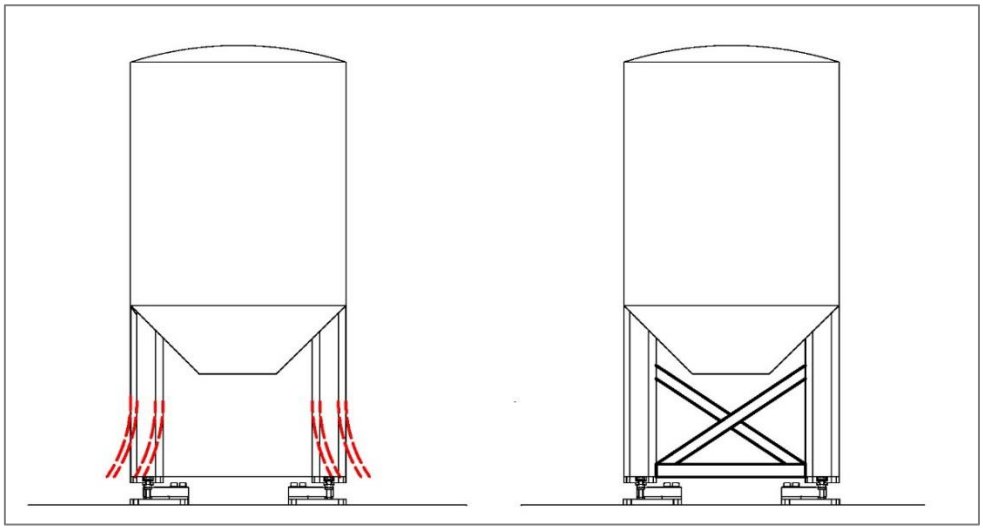


Fig. 7-a: Tank unreinforced

Fig. 7-b: Tank reinforced

From Utilcell, we hope this technical note can be of help to make an installation, only as a guideline and not serve as a contractual specification. We reserve the right to change the content of this technical note at any time without notice. Remaining at your disposal for any further information.